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Kim et al.

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(54) **LIGHT-EMITTING DIODE PACKAGE**

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(51) **Int. Cl.**

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H01L 33/56	(2010.01)
H01L 33/62	(2010.01)
H05B 33/08	(2006.01)
H04N 5/225	(2006.01)
H01L 33/44	(2010.01)
H01L 33/50	(2010.01)
H01L 33/00	(2010.01)

(52) **U.S. Cl.**

CPC ***H01L 33/62*** (2013.01); ***H01L 33/44*** (2013.01); ***H01L 33/50*** (2013.01); ***H01L 33/56*** (2013.01); ***H04N 5/2256*** (2013.01); ***H04N 5/2257*** (2013.01); ***H05B 33/0845*** (2013.01); *H01L 33/0079* (2013.01); *H01L 33/382* (2013.01)

(58) **Field of Classification Search**

CPC H01L 33/38; H01L 33/56; H01L 33/62

See application file for complete search history.

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(57) **ABSTRACT**

A light-emitting diode package includes a light-emitting structure, a first electrode pad and a second electrode pad connected with the light-emitting structure, an insulating pattern layer in contact with a bottom surface of the light-emitting structure and abutting the first and second electrode pads, a substrate including via-holes in contact with a bottom surface of the insulating pattern layer and exposing a portion of the first electrode pad and a portion of the second electrode pad, a first penetrating electrode and a second penetrating electrode that are disposed in the via-holes and respectively connected with the first and second electrode pads, a fluorescent material layer disposed on the light-emitting structure, a glass disposed on and spaced apart from the light-emitting structure with the fluorescent material layer therebetween.

20 Claims, 16 Drawing Sheets

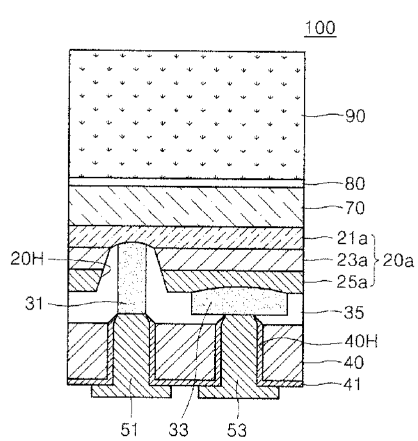

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FIG. 1

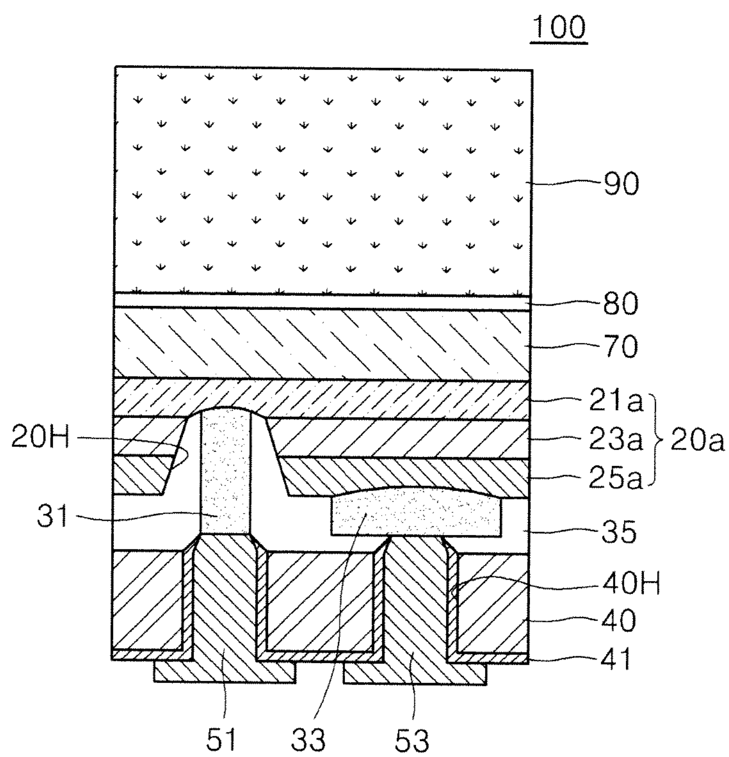


FIG. 2

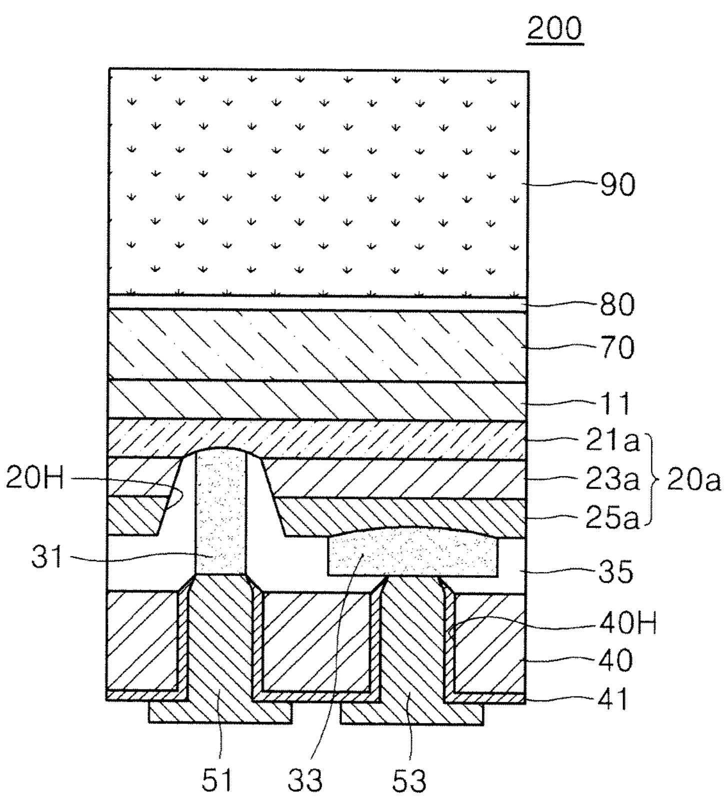


FIG. 3

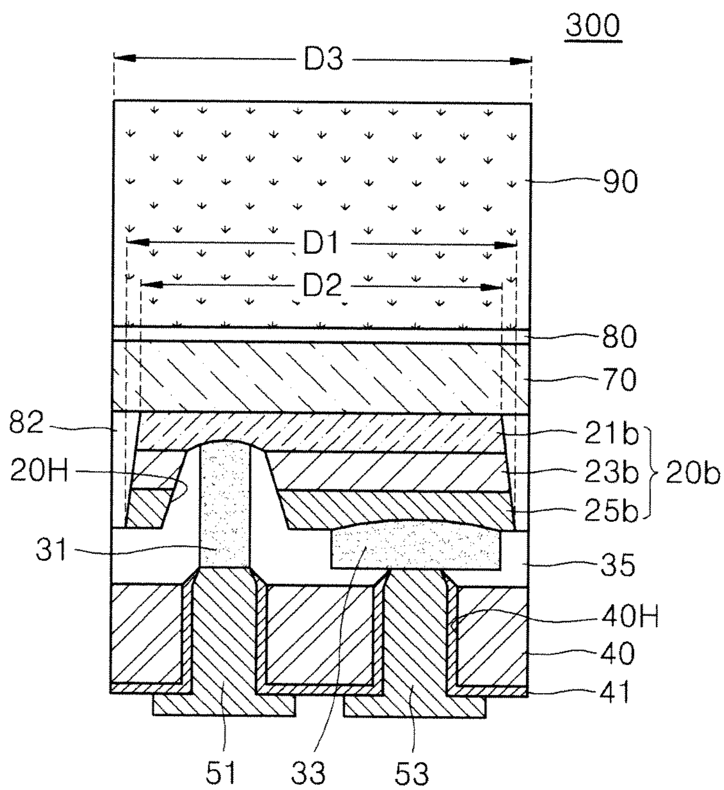


FIG. 4

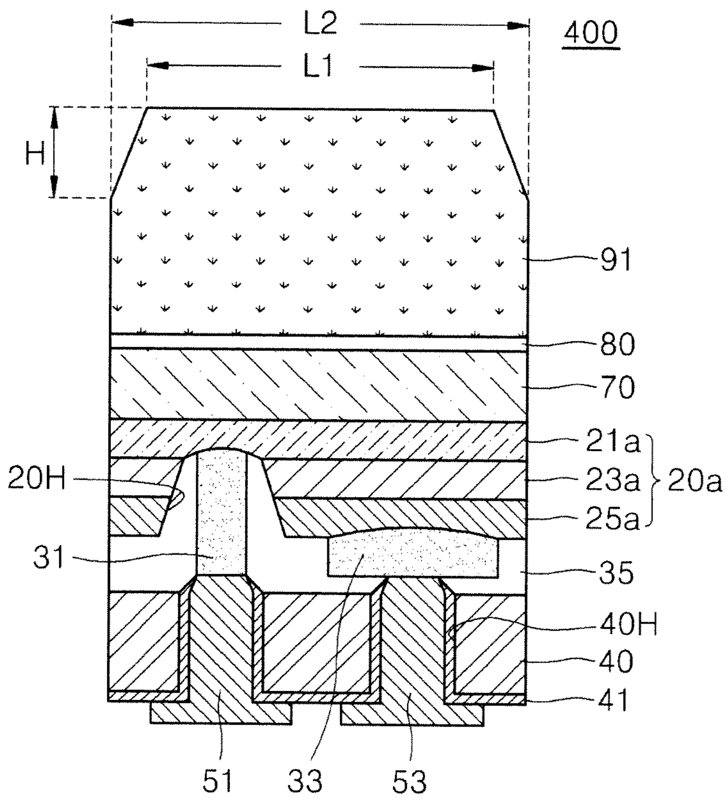


FIG. 5

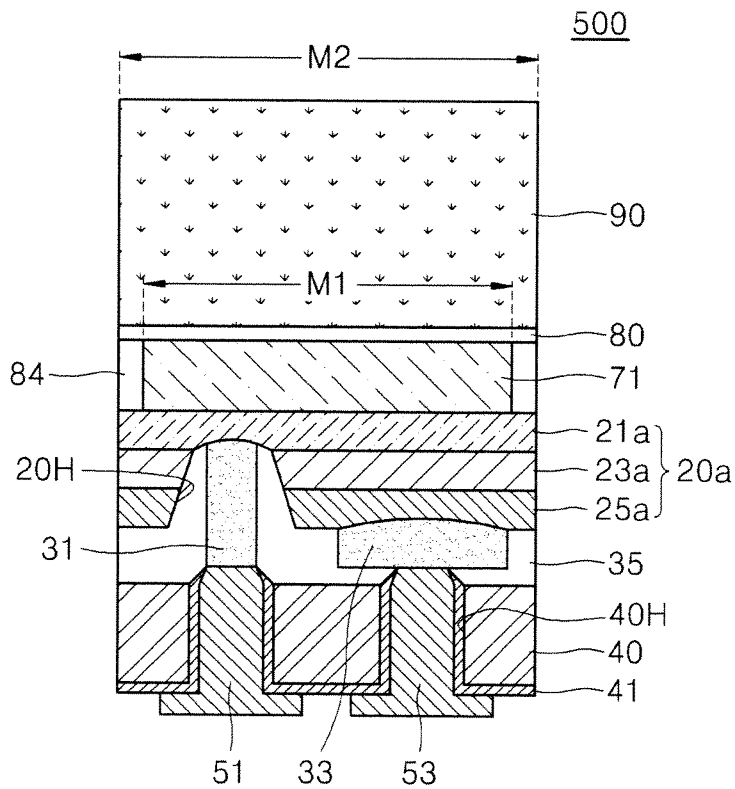


FIG. 6

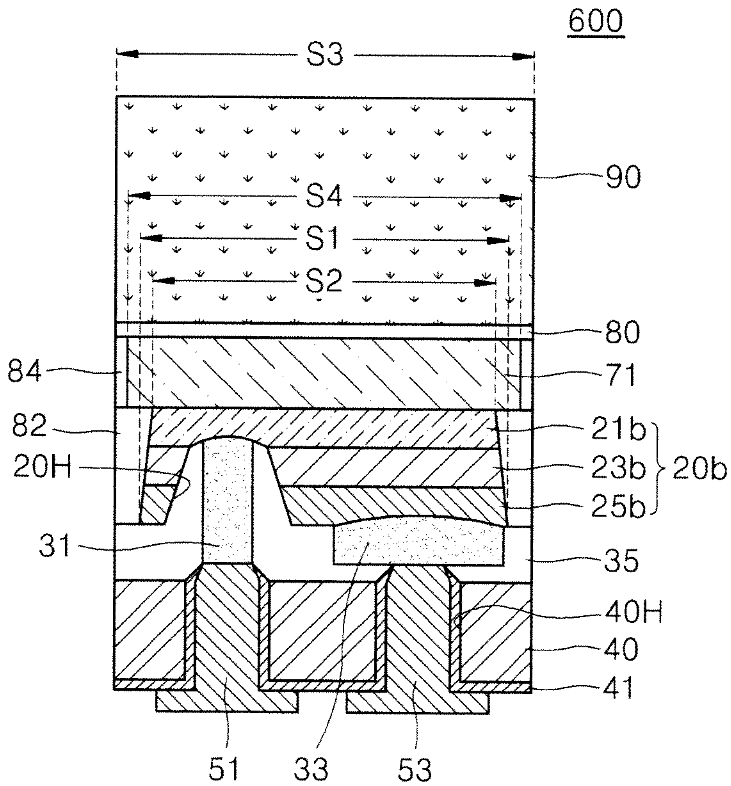

600
S3
90
S4
S1
S2
80
84
71
82
21b
20H
23b
20b
25b
31
35
40H
40
41
51
33
53

FIG. 7

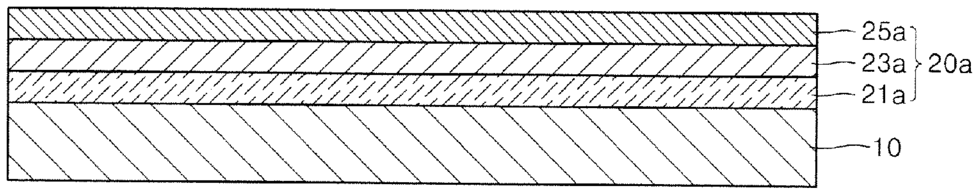


FIG. 8

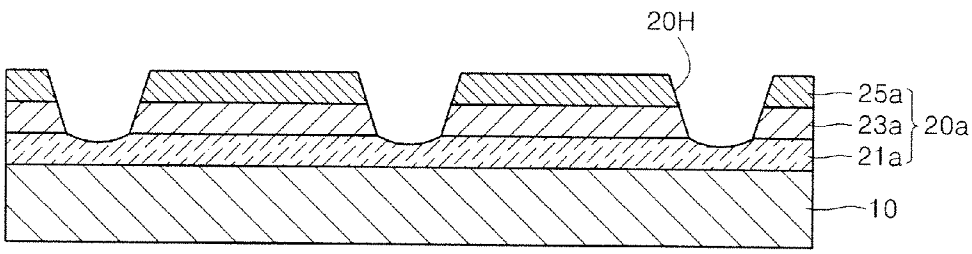


FIG. 9

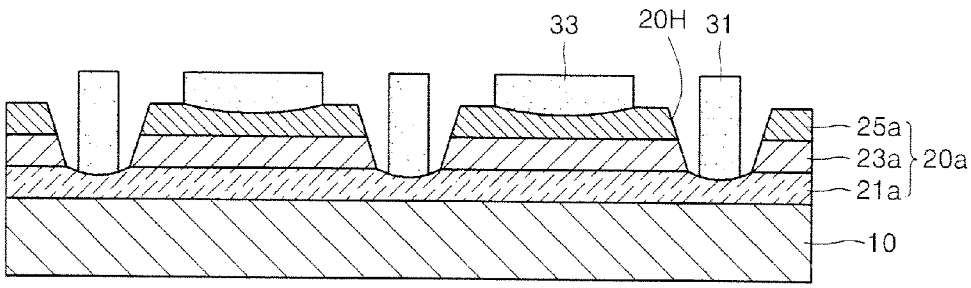


FIG. 10

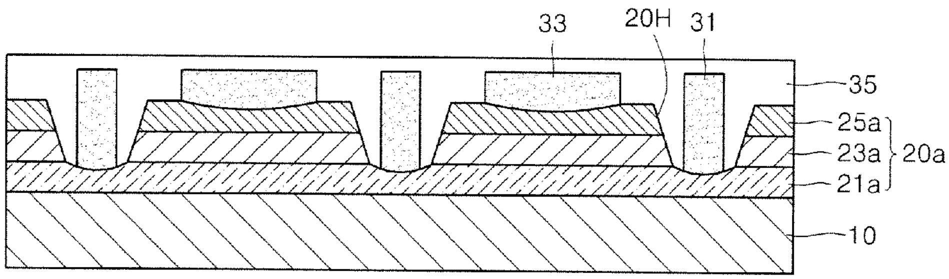


FIG. 11

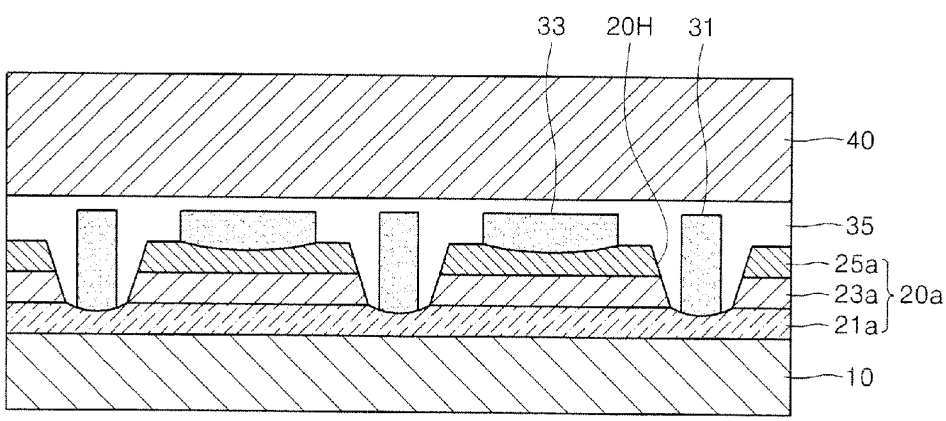


FIG. 12

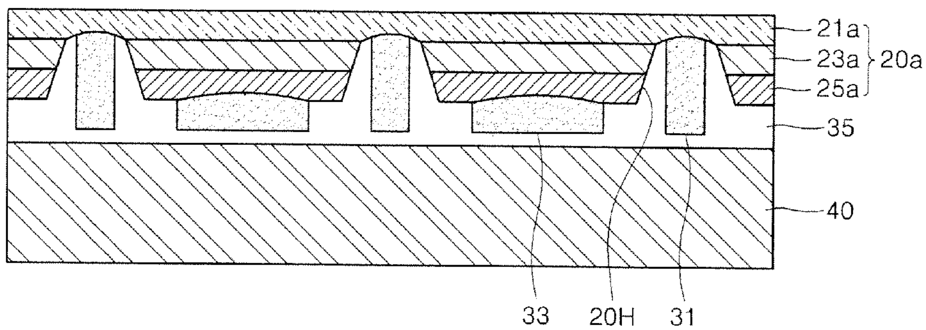


FIG. 13

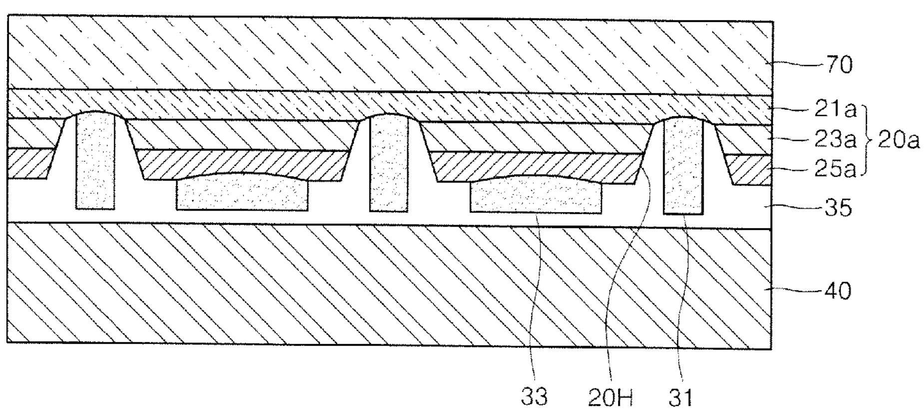


FIG. 14

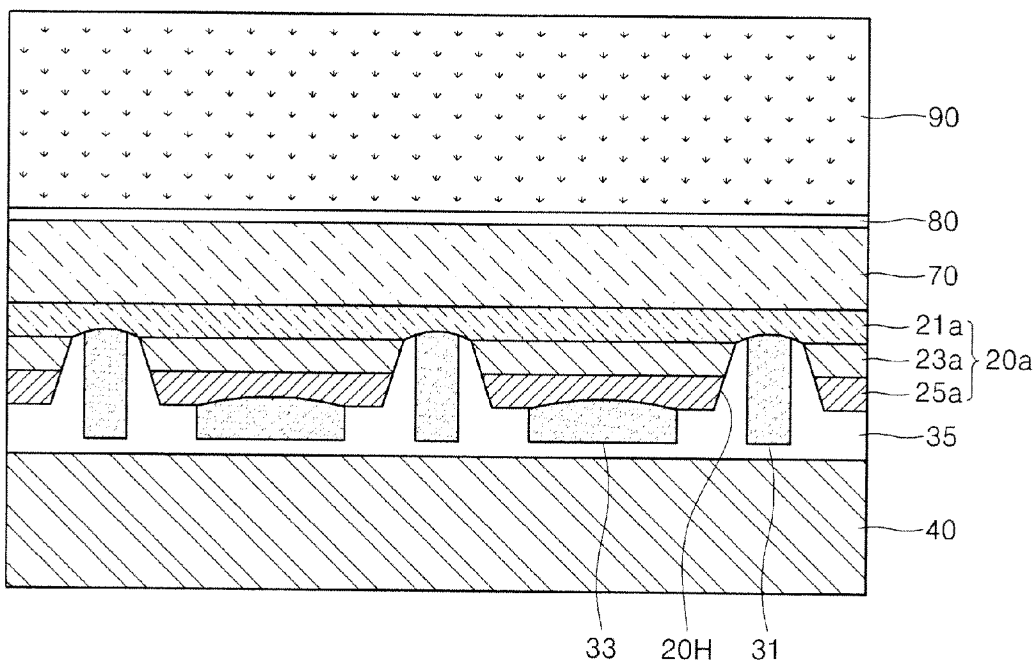


FIG. 15

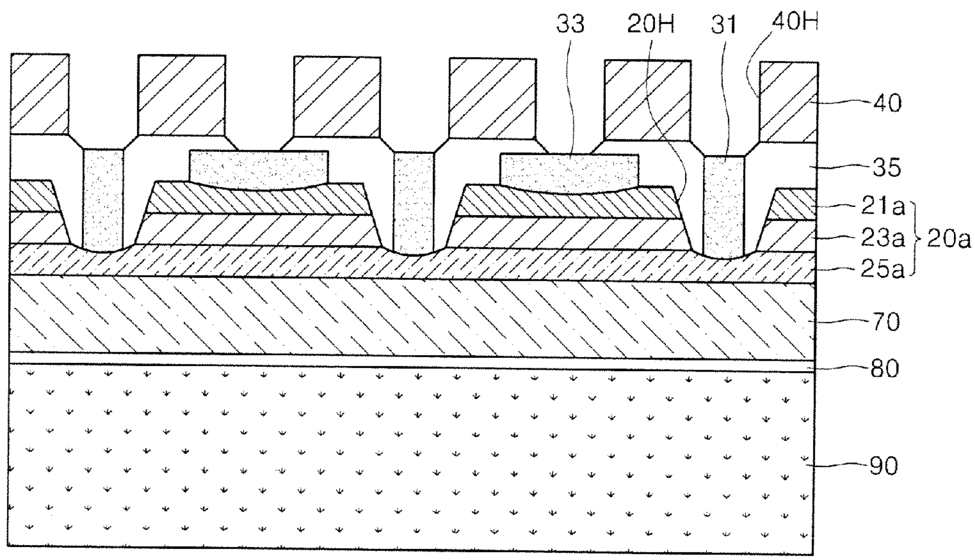


FIG. 16

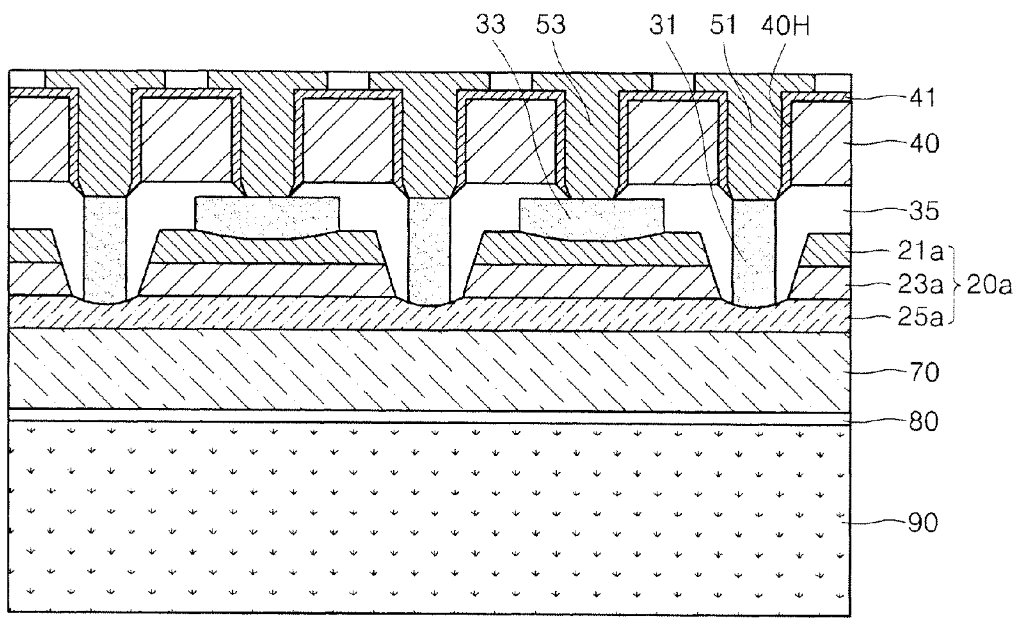


FIG. 17

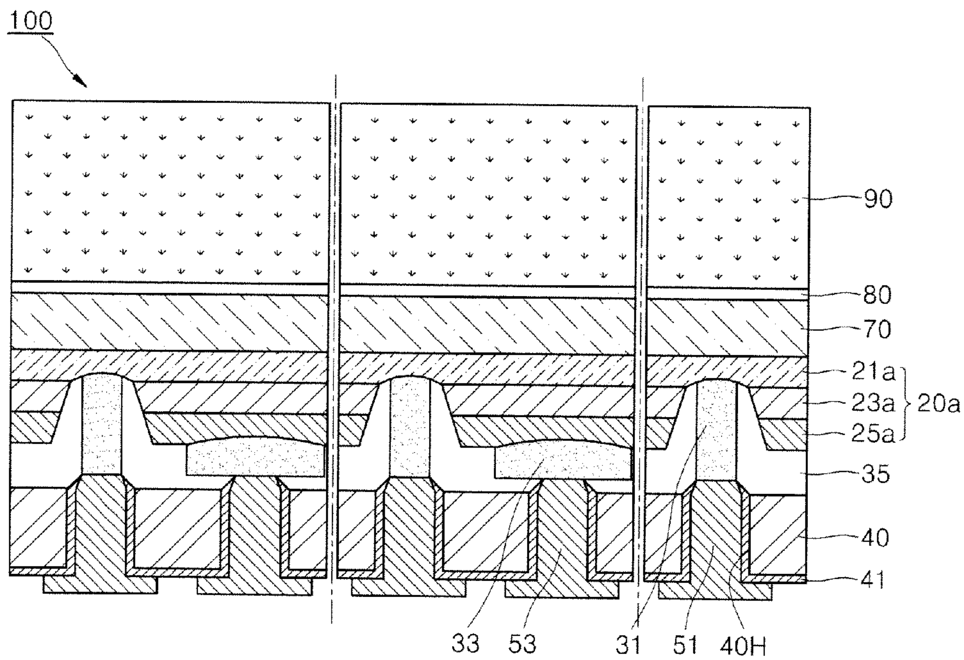


FIG. 18

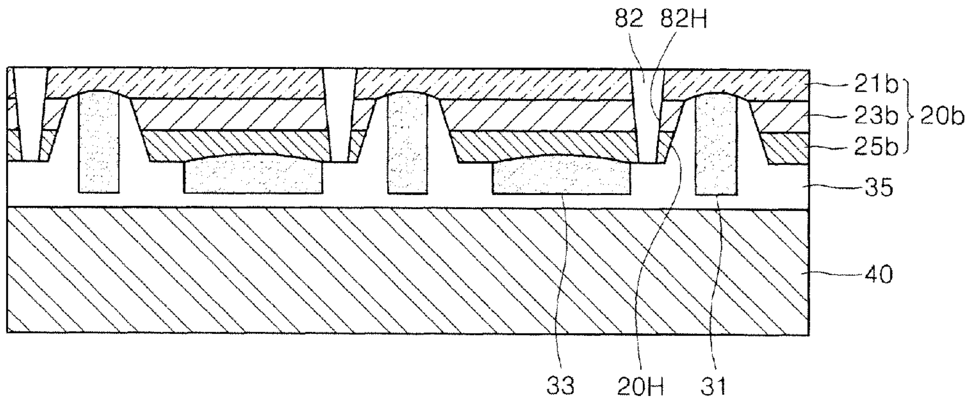
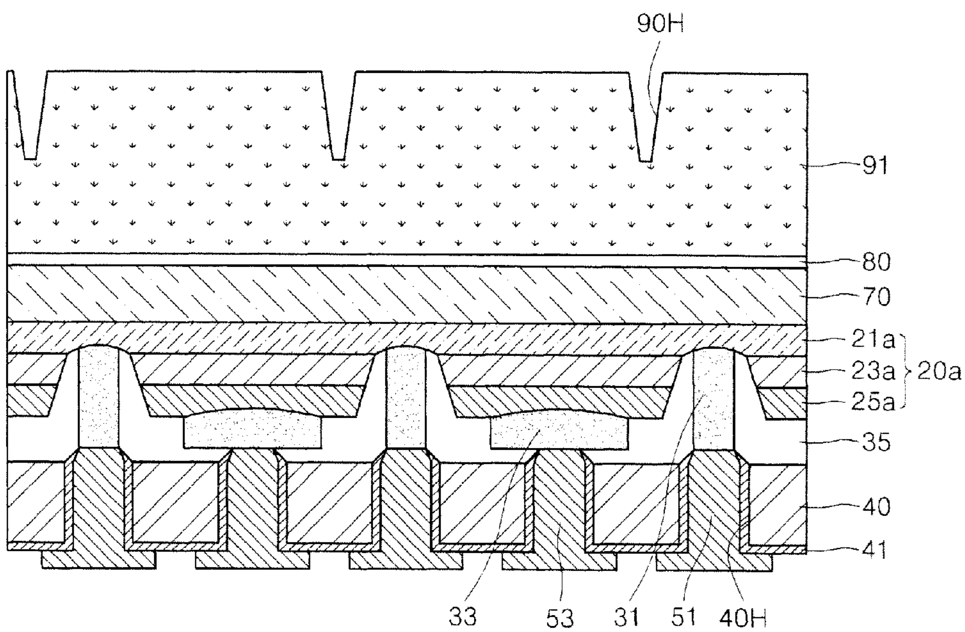

82
82H
21b
23b
25b
20b
35
40
33
20H
31

FIG. 19


90H
91
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70
21a
23a
25a
20a
35
40
41
33
53
31
51
40H

FIG. 20

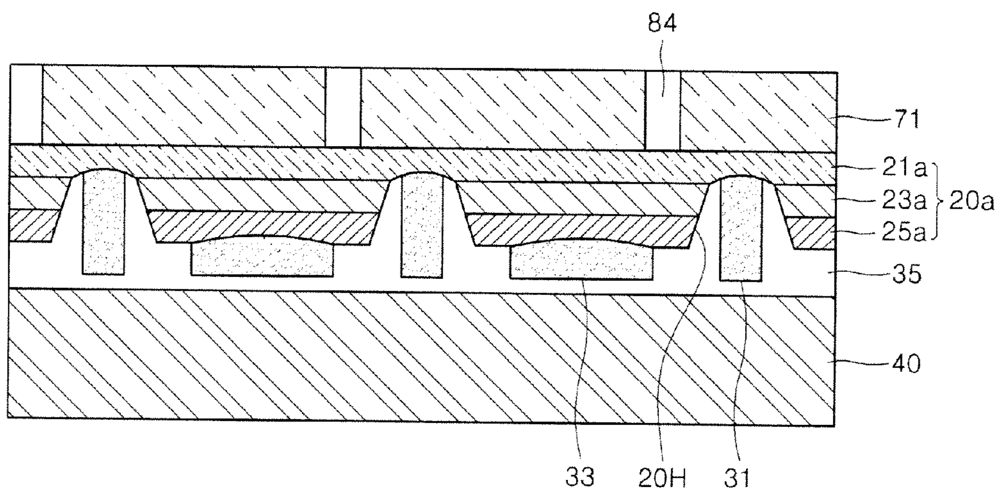


FIG. 21

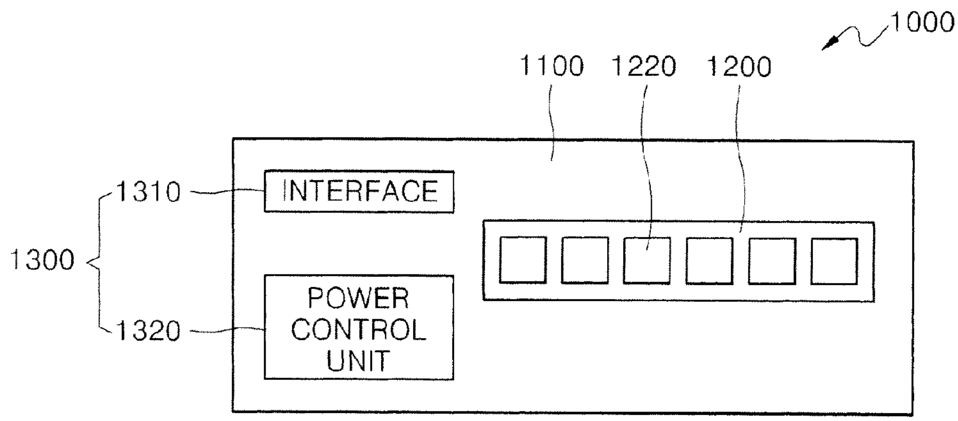
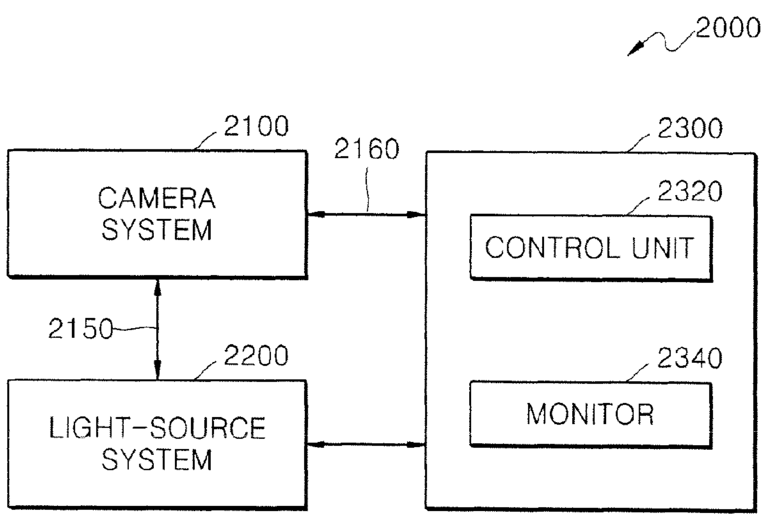

1000
1100
1220
1200
1310
INTERFACE
1300
1320
POWER CONTROL UNIT

FIG. 22


2000
2100
2160
2300
CAMERA SYSTEM
2320
CONTROL UNIT
2150
2200
2340
MONITOR
LIGHT-SOURCE SYSTEM

LIGHT-EMITTING DIODE PACKAGE

CROSS-REFERENCE TO RELATED APPLICATION

This application claims benefit of priority to Korean Patent Application No. 10-2014-0018032, filed on Feb. 17, 2014, in the Korean Intellectual Property Office, the entire content of which is incorporated herein by reference.

TECHNICAL FIELD

The present inventive concept relates to a light-emitting diode (LED) package, and more particularly, to a structure of an LED package which may be manufactured in an ultra small size.

BACKGROUND

Generally, in an LED package including a lead frame substrate, a chip is mounted inside the package. However, in the case of such a package, an additional substrate is needed and the size of the package increases, and thus, the cost of materials and manufacture increases due to an additional package process.

SUMMARY

The inventive concept provides a light-emitting diode (LED) package of an ultra small size, in order to prevent a size increase of the package and an increase in the cost of manufacture due to an additional package process.

One aspect of the inventive concept relates to an LED package including a light-emitting structure, a first electrode pad and a second electrode pad, an insulating pattern layer, a substrate, an insulating layer, a first penetrating electrode and a second penetrating electrode, a fluorescent material layer and a glass. The first electrode pad and the second electrode pad are connected with the light-emitting structure. The insulating pattern layer is in contact with a bottom surface of the light-emitting structure and abuts the first electrode pad and the second electrode pad. The substrate includes via-holes that are in contact with a bottom surface of the insulating pattern layer and expose a portion of the first electrode pad and a portion of the second electrode pad. The first penetrating electrode and the second penetrating electrode are disposed in the via-holes and are respectively connected with the first electrode pad and the second electrode pad. The fluorescent material layer is disposed on the light-emitting structure. The glass is disposed on and spaced apart from the light-emitting structure with the fluorescent material layer between the glass and the light-emitting structure.

The fluorescent material layer may include an adhesive fluorescent material layer.

The LED package may further include an adhesive material layer disposed between the fluorescent material layer and the glass.

A first width of the substrate may be greater than a second width of the bottom surface of the light-emitting structure. The LED package may further include a support layer disposed between the adhesive material layer and the insulating pattern layer to abut the light-emitting structure.

The support layer may include an adhesive material.

The second width may be greater than a third width of an upper surface of the light-emitting structure.

The LED package may further include a growth substrate of the light-emitting structure, which is interposed between the light-emitting structure and the fluorescent material layer.

A fourth width of an upper surface of the glass may be smaller than the first width of the substrate.

The glass may be tapered from a bottom surface of the glass to an upper surface of the glass.

Another aspect of the inventive concept encompasses an LED package including a light-emitting structure, a first electrode pad and a second electrode pad, an insulating pattern layer, a substrate, an insulating layer, a first penetrating electrode and a second penetrating electrode, a fluorescent material layer, a first support layer and a glass. The first electrode pad and the second electrode pad are connected with the light-emitting structure. The insulating pattern layer is in contacts with a bottom surface of the light-emitting structure and abuts the first electrode pad and the second electrode pad. The substrate including via-holes that are in contact with a bottom surface of the insulating pattern layer and expose a portion of the first electrode pad and a portion of the second electrode pad. The first penetrating electrode and the second penetrating electrode are disposed in the via-holes and are respectively connected with the first electrode pad and the second electrode pad. The fluorescent material layer is disposed on the light-emitting structure and has a second width which is smaller than a first width of the substrate. The first support layer abuts the fluorescent material layer disposed on the light-emitting structure. The glass is disposed on and spaced apart from the light-emitting structure with the fluorescent material layer between the glass and the light-emitting structure.

The first support layer may include an adhesive material.

The first support layer may include a fluorescent material.

A third width of the bottom surface of the light-emitting structure may be smaller than the first width of the substrate. The LED package may further include a second support layer abutting the light-emitting structure between an upper layer formed of the first support layer and the fluorescent material layer and a lower layer formed of the insulating pattern layer.

The first support layer may include an adhesive fluorescent material.

A third width of the bottom surface of the light-emitting structure may be smaller than the first width of the substrate. Also, the LED may further include a second support layer abutting the light-emitting structure between an upper layer including the first support layer and the fluorescent material layer and a lower layer including the insulating pattern layer.

The first support layer and the second support layer may include an identical material.

Still another aspect of the present inventive concept relates to a dimming system including a light-emitting module and a power supply unit. The light-emitting module includes the LED package. The power supply unit includes an interface configured to receive power and includes a power control unit configured to control power supplied to the light emitting module.

Still another aspect of the present inventive concept encompasses a light-processing system including a light-source system, a light guide, a camera system and a data process and analysis system. The light-source system includes the LED package. The camera system is connected with the light source system via the light guide and configured to output an image signal. The data process and analysis system is configured to process, analyse and store the image signal outputted from the camera system.

Still another aspect of the present inventive concept relates to a light-emitting diode (LED) package including a light-emitting structure, a first electrode pad and a second electrode pad, an insulating pattern layer, a substrate, an insulating layer, and a first penetrating electrode and a second penetrating electrode. The light-emitting structure includes a first semiconductor layer, an active layer and a second semiconductor layer. The first electrode pad and the second electrode pad are respectively connected with the first semiconductor layer and the second semiconductor layer of the light-emitting structure. The insulating pattern layer is in contact with a bottom surface of the light-emitting structure and disposed between the first electrode pad and the second electrode pad. The substrate includes via-holes that penetrate the substrate and expose a portion of the first electrode pad and a portion of the second electrode pad. The first penetrating electrode and the second penetrating electrode are disposed in the via-holes and are respectively connected with the first electrode pad and the second electrode pad. A first width of the bottom surface of the light-emitting structure is greater than a second width of an upper surface of the light-emitting surface and smaller than a third width of the substrate.

BRIEF DESCRIPTION OF THE DRAWINGS

The above and other aspects, features and other advantages of the inventive concept will be more clearly understood from the following detailed description taken in conjunction with the accompanying drawings in which like reference characters may refer to the same or similar parts throughout the different views. The drawings are not necessarily to scale, emphasis instead being placed upon illustrating the principles of the embodiments of the present inventive concept. In the drawings, the thickness of layers and regions may be exaggerated for clarity.

FIGS. **1** through **6** are cross-sectional views of light-emitting diode (LED) packages according to exemplary embodiments of the inventive concept.

FIGS. **7** through **17** are cross-sectional views for describing processes for manufacturing an LED package, according to exemplary embodiments of the inventive concept.

FIG. **18** is a cross-sectional view for describing an additional process for manufacturing an LED package, according to exemplary embodiments of the inventive concept.

FIG. **19** is a cross-sectional view for describing an additional process for manufacturing an LED package, according to exemplary embodiments of the inventive concept.

FIG. **20** is a cross-sectional view for describing a process performed instead of the process of FIG. **13** for manufacturing LED packages, according to exemplary embodiments of the inventive concept.

FIG. **21** is a view of a dimming system including a semiconductor light-emitting device, according to exemplary embodiments of the inventive concept.

FIG. **22** is a block diagram of a light-processing system including LED packages according to exemplary embodiments of the inventive concept.

DETAILED DESCRIPTION

Exemplary embodiments are described herein with reference to cross-sectional illustrations that are schematic illustrations of exemplary embodiments (and intermediate structures). As such, variations from the shapes of the illustrations as a result, for example, of manufacturing techniques and/or tolerances, are to be expected. Thus, exemplary embodiments should not be construed as limited to the particular shapes of regions illustrated herein but may be to include deviations in shapes that result, for example, from manufacturing. Like reference numerals in the drawings denote like elements, and thus their description will be omitted. In the drawings, the thicknesses of layers and regions are exaggerated for clarity.

The terminology used herein is for describing particular embodiments and is not intended to be limiting of exemplary embodiments. As used herein, the singular forms "a," "an," and "the," are intended to include the plural forms as well, unless the context clearly displays otherwise. It will be further understood that the terms "comprises," "comprising," "includes," and/or "including," when used herein, specify the presence of stated features, integers, steps, operations, elements, and/or components, but do not preclude the presence or addition of one or more other features, integers, steps, operations, elements, components, and/or groups thereof.

Unless otherwise defined, all terms (including technical and scientific terms) used herein have the same meaning as commonly understood by one of ordinary skill in the art to which exemplary embodiments belong. It will be further understood that terms, such as those defined in commonly used dictionaries, should be interpreted as having a meaning that is consistent with their meaning in the context of the relevant art and will not be interpreted in an idealized or overly formal sense unless expressly so defined herein.

Hereinafter, "an upper surface" and "a bottom surface" respectively denote an upper portion and a bottom portion in the drawings.

Hereinafter, exemplary embodiments of the inventive concept will be described in detail with reference to the accompanying drawings.

FIG. **1** is a cross-sectional view of a light-emitting diode (LED) package **100** according to exemplary embodiments of the inventive concept.

Referring to FIG. **1**, the LED package **100** may include a light-emitting structure **20***a*, a first electrode pad **31** and a second electrode pad **33**, an insulating pattern layer **35**, a substrate **40**, an insulating layer **41**, and a first penetrating electrode **51** and a second penetrating electrode **53**. The first electrode pad **31** and a second electrode pad **33** may be connected with the light-emitting structure **20***a* below the light-emitting structure **20***a*. The insulating pattern layer **35** may define or abut the first electrode pad **31** and the second electrode pad **33** and may be in contact with a bottom surface of the light-emitting structure **20***a*. The substrate **40** may include via-holes **40**H in contact with a bottom surface of the insulating pattern layer **35** and expose the first electrode pad **31** and the second electrode pad **33**. The insulating layer **41** may cover a bottom surface of the substrate **40** and inner walls of the via-holes **40**H. The first penetrating electrode **51** and the second penetrating electrode **53** may be respectively connected with the first electrode pad **31** and the second electrode pad **33**. Also, above the light-emitting structure **20***a*, the LED package **100** may include a fluorescent material layer **70** formed on an upper surface of the light-emitting structure **20***a*, an adhesive material layer **80** formed on the fluorescent material layer **70**, and a glass **90** formed on the adhesive material layer **80**.

The light-emitting structure **20***a* may include a first semiconductor layer **21***a*, a second semiconductor layer **25***a*, and an active layer **23***a* interposed between the first semiconductor layer **21***a* and the second semiconductor layer **25***a*. The first semiconductor layer **21***a* and the second semiconductor layer **25***a* may be a p-type semiconductor layer and an n-type semiconductor layer, respectively, or vice versa. In some embodiments of the present inventive concept, the first semiconductor layer **21***a* may include an n-GaN layer and the second semiconductor layer **25***a* may include a p-GaN layer.

The active layer **23***a* may emit light having a predetermined energy by recombination of electrons and holes, and may be formed as a multi quantum well (MQW) structure in which a quantum well layer and a quantum barrier layer are alternately stacked. In some embodiments of the present inventive concept, the MQW structure may include an InGaN/GaN structure.

The structure below the light-emitting structure **20***a* will be described first. A contact hole **20**H may be formed in the light-emitting structure **20***a* to penetrate the second semiconductor layer **25***a* and the active layer **23***a* to expose a portion of the first semiconductor layer **23***a*.

The first electrode pad **31** may be formed in the contact hole **20**H to be connected with the first semiconductor layer **21***a* and the second electrode pad **33** may be formed in the contact hole **20**H to be connected with the second semiconductor layer **25***a*. The second electrode pad **33** may be formed to be wider than the first electrode pad **31**. The insulating pattern **35** may be formed to cover an inner portion of the contact hole **20**H and side walls of the first electrode pad **31** and the second electrode pad **33** so as to define or abut the first electrode pad **31** and the second electrode pad **33**. The insulating pattern **35** may be formed to cover a portion of a bottom surface of the first electrode pad **31** and a portion of a bottom surface of the second electrode pad **33**. The first electrode pad **31** may be electrically separated from the active layer **23***a* and the second electrode pad **33** by being surrounded by the insulating pattern **35**.

The substrate **40** may include the via-holes **40**H in contact with the bottom surface of the insulating pattern **35** and expose a portion of the first electrode pad **31** and a portion of the second electrode pad **33**. The via-holes **40**H may be appropriately adjusted in teems of their shapes and pitches to lower a contact resistance between the first electrode pad **31** and the first penetrating electrode **51** and between the second electrode pad **33** and the second penetrating electrode **53**. The insulating layer **41** may be formed in inner walls of the via-holes **40**H and in the bottom surface of the substrate **40**. In some embodiments of the present inventive concept, the substrate **40** may be formed of silicon (Si) or Si doped with impurities.

The first penetrating electrode **51** and the second penetrating electrode **53** may be formed to fill the via-holes **40**H covered by the insulating layer **41** to be respectively connected with the first electrode pad **31** and the second electrode pad **33**. The first penetrating electrode **51** and the second penetrating electrode **53** may be respectively connected with a first external connection terminal and a second external connection terminal which are formed to cover a portion of the bottom surface of the substrate **40** covered by the insulating layer **41**. In some embodiments of the present inventive concept, the first penetrating electrode **51** and the first external connection terminal, and the second penetrating electrode **53** and the second external connection terminal may be integrally formed.

Next, the structure above the light-emitting structure **20***a* will be described.

The fluorescent material layer **70** may be formed on an upper surface of the light-emitting structure **20***a*. The fluorescent material layer **70** may include a methyl-based fluorescent material, a phenyl-based fluorescent material, or a YAG ($Y_3Al_5O_{12}$)-based fluorescent material. The fluorescent material layer **70** may convert light generated from the light-emitting structure **20***a* into a desired light color. The adhesive material layer **80** may be formed on the fluorescent material layer **70**. The adhesive material layer **80** may be a material layer to make the fluorescent material layer **70** and the glass **90** adhere to each other. In some embodiments of the present inventive concept, the adhesive material layer **80** may include a silicone resin or an epoxy resin. In some embodiments of the present inventive concept, the fluorescent material layer **70** may include an adhesive fluorescent material layer, and in this case, the adhesive material layer **80** may be omitted.

The glass **90** may be formed on the adhesive material layer **80**. The light generated from the active layer **23***a* may pass through the glass **90**. The glass **90** may play a role of enhancing the durability of the LED package **100** against external shocks. Also, the glass **90** may support the substrate **40**, which has a low mechanical intensity, in a process of forming the via-holes **40**H in the substrate **40**, thereby allowing the substrate **40** to be ground to be sufficiently thin. Accordingly, pitch sizes of the via-holes **40**H may be reduced to prevent an occurrence of voids in the via-holes **40**H, and thus, the operating reliability of the LED may increase.

FIG. **2** is a cross-sectional view of an LED package **200** according to exemplary embodiments of the inventive concept. In FIGS. **2** through **20**, like reference numerals in FIG. **1** denote like elements, and their detailed descriptions will not be repeated.

Referring to FIG. **2**, the LED package **200** of FIG. **2** may be different from the LED package **100** of FIG. **1** in that the LED package **200** may further include a growth substrate **11** of the light-emitting structure **20***a*, which is interposed between the light-emitting structure **20***a* and the fluorescent material layer **70**.

The growth substrate **11** may be an element that is used in a process of depositing the light-emitting structure **20***a*. In the LED package **200** of FIG. **2**, the first semiconductor layer **21***a*, the active layer **23***a*, and the second semiconductor layer **25***a* may be sequentially deposited on the growth substrate **11** to form the light-emitting structure **20***a*. Then, all of the growth substrate **11** may be removed and the fluorescent layer **70** may be formed on the light-emitting structure **20***a*. Alternatively, in the LED package **200** according to exemplary embodiments of the present inventive concept, all of or a portion of the growth substrate **11** may not be removed. A portion of a growth substrate **10** of FIGS. **7** through **17** may be removed to form the growth substrate **11** of FIG. **2**. In some embodiments of the present inventive concept, the growth substrate **11** may be formed of a transparent material.

FIG. **3** is a cross-sectional view of an LED package **300** according to exemplary embodiments of the inventive concept.

Referring to FIG. **3**, the LED package **300** may be different from the LED package **100** of FIG. **1** in that the LED package **300** may have a different light-emitting structure **20***b* and further includes a support layer **82**.

A first width D**1** of a bottom surface of the light-emitting structure **20***b* and a second width D**2** of an upper surface of the light-emitting structure **20***b* may be smaller than a third width D**3** of the substrate **40**, thereby allowing a sawing line not to be in contact with the light-emitting structure **20***b*, when an LED package according to an exemplary embodiment of the inventive concept is formed at a wafer level and is finally sawed in a chip size. When the first semiconductor layer **21***b*, the active layer **23***b*, and the second semiconductor layer **25***b* are directly sawed mechanically, cracks may occur on the semiconductor layers **21***b* and **25***b*, and the active layer **23***b*. The LED package **300** may prevent such a problem and protect the light-emitting structure **20***b*.

The first width D**1** may be greater than the second width D**2**. It is illustrated in FIG. **3** that the first width D**1** is greater than the second width D**2**. However, the inventive concept is not limited thereto, and shapes of widths according to a height of the light-emitting structure **20***b* may include various shapes of widths that can be formed by an etching process which removes edges of the light-emitting structure **20***b*.

The support layer **82** may be formed between the fluorescent material layer **70** and the insulating pattern layer **35** to define or abut the light-emitting structure **20***b*. The support layer **82** may support between the insulating pattern **35** and the adhesive material layer **80**. The support layer **82** may include an adhesive material layer and function to make the insulating pattern **35** and the adhesive material layer **80** adhere to each other. In some embodiments of the present inventive concept, the support layer **82** may be a silicone resin or an epoxy resin.

In some embodiments of the present inventive concept, the second width D**2** of the upper surface of the light-emitting structure **20***b* may be smaller than the first width D**1** of the bottom surface of the light-emitting structure **20***b*.

In some embodiments of the present inventive concept, the first width D**1** of the bottom surface of the light-emitting structure **20***b* may be the same as the third width D**3** of the substrate **40**.

FIG. **4** is a cross-sectional view of an LED package **400** according to exemplary embodiments of the inventive concept.

Referring to FIG. **4**, the LED package **400** may be different from the LED package **100** of FIG. **1** in that the LED package **400** may have a glass **91** having a shape different from the shape of the glass **90**.

A first width L**1** of an upper surface of the glass **91** of the LED package **400** may be smaller than a second width L**2** of the substrate **40**. This may be formed by performing an etching process along a sawing line before performing a mechanical sawing process along the sawing line, when an LED package according to an exemplary embodiment of the inventive concept is formed at a wafer level and is finally sawed in a chip size. By performing the etching process along the sawing line, grooves may be formed at edges of the glass **91** by a predetermined depth H from the upper surface of the glass **91**. Accordingly, the first width L**1** of the upper surface of the glass **91** may be smaller than the second width L**2** of the substrate **40**.

In some embodiments of the present inventive concept, the glass **91** may be tapered from a predetermined point of a vertical height of the glass **91** to the upper surface of the glass **91**. In some embodiments of the present inventive concept, the glass **91** may be tapered from a bottom surface of the glass **91** to the upper surface of the glass **91**.

It is illustrated in FIG. **4** that widths get smaller from the second width L**2** to the first width L**1**, however, the inventive concept is not limited thereto. Shapes of widths according to a height of the glass **91** may include various shapes of widths that can be formed by the etching process along a sawing surface of the glass **91**.

FIG. **5** is a cross-sectional view of an LED package **500** according to exemplary embodiments of the inventive concept.

Referring to FIG. **5**, the LED package **500** may be different from the LED package **100** of FIG. **1** in that the LED package **500** may have a fluorescent material layer **71** having a shape different from the shape of the fluorescent material layer **70** and may further include a support layer **84**.

A first width M**1** of the fluorescent material layer **71** formed on the light-emitting structure **20***a* may be smaller than a second width M**2** of the substrate **40**. Such a structure may be formed by separating the fluorescent material layer **71** in a chip size and arranging the separated fluorescent material layer **71** on the light-emitting structure **20***a*.

The support layer **84** may be formed between the adhesive material layer **80** and the light-emitting structure **20***a* to define or abut the fluorescent material layer **71**. The support layer **84** may support between the adhesive material layer **80** and the light-emitting structure **20***a*. Also, the support layer **84** may include an adhesive material layer such that the adhesive material layer **80** and the light-emitting structure **20***a* adhere to each other. In some embodiments of the present inventive concept, the support layer **84** may be a silicone resin or an epoxy resin.

The support layer **84** may include a fluorescent material layer. In this case, a portion of a light generated from the light-emitting structure **20***a* may pass through the support layer **84** and may be converted to a desired color of light.

In some embodiments of the present inventive concept, the support layer **84** may include an adhesive fluorescent material layer.

FIG. **6** is a cross-sectional view of an LED package **600** according to exemplary embodiments of the inventive concept.

Referring to FIG. **6**, the LED package **600** may be different from the LED package **500** of FIG. **5** in that the LED package **600** may have the light-emitting structure **20***b* having a shape different from the shape of the light-emitting structure **20***b* of FIG. **5**, and may further include the second support layer **82**.

A first width S**1** of a bottom surface of the light-emitting structure **20***b* and a second width S**2** of an upper surface of the light-emitting structure **20***b* may be smaller than a third width S**3** of the substrate **40**. As described above, the light-emitting structure **20***b* has such a shape in order to prevent cracks that may occur on the semiconductor layers **21***b* and **25***b*, and the active layer **23***b* when the semiconductor layers **21***b* and **25***b*, and the active layer **23***b* are directly sawed mechanically.

The first width S**1** of the light-emitting structure **20***b* may be greater than the second width S**2**. It is illustrated in FIG. **6** that the first width S**1** is greater than the second width S**2**, however the inventive concept is not limited thereto. Shapes of widths according to a height of the light-emitting structure **20***b* may include various shapes of widths that can be formed by an etching process that removes edges of the light-emitting structure **20***b*.

The first support layer **84** may be formed between the adhesive material layer **80** and the light-emitting structure **20***b* to define or abut the fluorescent material layer **71**. The second support layer **82** may be formed between an upper layer formed of the first support layer **84** and the fluorescent material layer **71** and a lower layer formed of the insulating pattern layer **35** to define or abut the light-emitting structure **20***b*. The second support layer **82** may support between the upper layer formed of the first support layer **84** and the fluorescent material layer **71**, and the lower layer formed of the insulating pattern **35**. The second support layer **82** may include an adhesive material layer such that the upper layer and the lower layer adhere to each other. In some embodiments of the present inventive concept, the second support layer **82** may be a silicone resin or an epoxy resin.

In some embodiments of the present inventive concept, the first width S**1** of the bottom surface of the light-emitting structure **20***b* may be the same as the third width S**3** of the substrate **40**.

In some embodiments of the present inventive concept, the first support layer **84** and the second support layer **82** may include the same material layer as each other. For example, the first support layer **84** and the second support layer **82** may include an adhesive material layer, a fluorescent material layer, or an adhesive fluorescent material layer.

In some embodiments of the present inventive concept, a fourth width S4 of the fluorescent material layer **71** may be greater than the first width SI of the bottom surface of the light-emitting structure **20***b*.

FIGS. **7** through **20** are cross-sectional views for describing a method of manufacturing an LED package according to exemplary embodiments of the inventive concept.

In FIGS. **7** through **17**, the method of manufacturing the LED package **100** of FIG. **1** will be described, according to exemplary embodiments of the inventive concept.

Referring to FIGS. **7** through **10**, the first semiconductor layer **21***a*, the active layer **23***a*, and the second semiconductor layer **25***a* of the light-emitting structure **20***a* may be sequentially grown on a cylindrical surface of a growth substrate **10**. The substrate **10** may be formed of a material, such as sapphire, SiC, or GaN. The contact hole **20**H may be formed in the light-emitting structure **20***a* by etching portions of the active layer **23***a* and the second semiconductor layer **25***a* to expose at least a portion of the first semiconductor layer **21***a* (see FIG. **8**). The first electrode pad **31** connected with the first semiconductor layer **21***a* that is exposed in the contact hole **20**H and the second electrode pad **33** connected with the second semiconductor layer **25***a* may be formed by using a mask pattern (not shown) that defines the first electrode pad **31** and the second electrode pad **33** (see FIG. **9**). Then, the mask pattern may be removed. And then, the insulating pattern **35** may be formed to define or abut the first electrode pad **31** and the second electrode pad **33** and cover a surface of the light-emitting structure **20***a* (see FIG. **10**). In this case, the insulating pattern **35** may be formed to cover upper surfaces of the first electrode pad **31** and the second electrode pad **33**.

Referring to FIG. **11**, the substrate **40** may be made adhere to the insulating pattern **35** at a wafer level. For improved support intensity in the manufacturing process, the substrate **40** may be thicker than a substrate required in the completed LED package **100**. As it will be described later, the substrate **40** may be ground to be sufficiently thin in an operation of FIG. **14** to satisfy the thickness required by the LED package **100**.

Referring to FIG. **12**, the growth substrate **10** of the light-emitting structure **20***a* may be removed or separated from the light-emitting structure **20***a* by performing an etching process or a mechanical removal process. The removal process of the growth substrate **10** may also be performed even when the upper surface and the bottom surface of a product of the operation of FIG. **11** are reversed.

All or a portion of the growth substrate **10** may not be removed, according to necessity. The LED package **200** of FIG. **2** may be manufactured such that only a portion of the growth substrate **10** of FIG. **12** is removed and the growth substrate **11** having a smaller thickness than the growth substrate **10** on which the light-emitting structure **20***a* is grown remains between the light-emitting structure **20***a* and the fluorescent material layer **70**.

Referring to FIG. **13**, the fluorescent material layer **70** may be formed at a wafer level to cover an entire upper surface of the light-emitting structure **20***a*. An adhesive material layer may be formed between the fluorescent material layer **70** and the first semiconductor layer **21***a* to make the fluorescent material layer **70** adhere to the first semiconductor layer **21***a* of the light-emitting structure **20***a*.

Referring to FIG. **14**, the adhesive material layer **80** may be formed to cover an entire surface of the fluorescent material layer **70**. However, when the fluorescent material layer **70** includes the adhesive fluorescent material layer as described above, the process of forming the adhesive material layer **80** may be omitted.

The glass **90** may be formed on the adhesive material layer **80**. The glass **90** may be formed to be sufficiently thick to maintain a mechanical intensity of the LED package **100** of FIG. **1**. As the glass **90** adheres to the adhesive material layer **80**, the LED package **100** at a wafer level may maintain sufficient support intensity without a help of the substrate **40**. Accordingly, the substrate **40** may go through an operation of being ground to be sufficiently thin to satisfy the thickness desired by the LED package **100**. Since the substrate **40** is ground to be sufficiently thin, a depth of the substrate **40** may be small, and thus, a pitch of a via-hole formed in the substrate **40** may be selectively adjusted and an occurrence of voids that may be generated when forming a penetrating electrode by filling the via-hole may be prevented.

Referring to FIG. **15**, the via-holes **40**H may be formed in the substrate **40** to expose portions of the first electrode pad **31** and the second electrode pad **33**. The via-holes **40**H may be formed by an etching process by using a mask pattern (not shown).

Referring to FIG. **16**, the insulating layer **41** may be formed to expose partial surfaces of the first electrode pad **31** and the second electrode pad **33** and to cover inner walls of the via-holes **40**H and an upper surface of the substrate **40**. The first penetrating electrode **51** may be formed by filling, with an electrode material, the via-hole **40**H, the inner walls of which are covered by the insulating layer **41** and through which a partial upper surface of the first electrode pad **31** is exposed. Likewise, the second penetrating electrode **53** may be formed by filling, with an electrode material, the via-hole **40**H, the inner walls of which are covered by the insulating layer **41** and through which a partial upper surface of the second electrode pad **33** is exposed. In some embodiments of the present inventive concept, a first external connection terminal and a second external connection terminal respectively connected with the upper surfaces of the first penetrating electrode **51** and the second penetrating electrode **53** may further be formed.

Referring to FIG. **17**, the upper surface and the bottom surface of a product of the operation of FIG. **16** may be reversed. A chip unit may be determined to include at least one pair of the first electrode pad **31** and the second electrode pad **33**, and a resulting product thereof, formed at a wafer level, may be sawed in a chip size, to manufacture the LED package **100**.

FIG. **18** is a cross-sectional view for describing a method of manufacturing the LED package **300**, according to exemplary embodiments of the inventive concept. The method of manufacturing the LED package **300** may include the method steps of manufacturing the LED package **100**, as illustrated in FIGS. **7** through **17**. However, the method of manufacturing the LED package **300** may further include an operation of FIG. **18** between the operation of FIG. **12** and the operation of FIG. **13**.

Referring to FIG. **18**, a narrow trench **82**H may be formed in the light-emitting structure **20***b* by removing a portion of the light-emitting structure **20***a* (see FIG. **12**) along a sawing line along which the light-emitting structure **20***a* formed in the operation of FIG. **12** is to be sawed in a chip size. The light-emitting structure **20***b* at a wafer level may be separated in a chip size by the trench **82**H. The support layer **82**, which is an adhesive material, may be formed in the trench **82**H. The support layer **82** may space the light-emitting structure **20***b* apart from the sawing line to prevent cracks that may occur on the light-emitting structure **20***b* in the operation of sawing the LED package **300** at a wafer level in a chip size.

Sequential processes of FIGS. **13** through **17** may be performed on an entire surface of the light-emitting structure **20***b* and the support layer **82**, as illustrated in FIG. **18**, to manufacture the LED package **300**. In this case, the light-emitting structure **20***a* in the sequential processes of FIGS. **13** through **17** may be the light-emitting structure **20***b* and the support layer **82**, as illustrated in FIG. **18**.

FIG. **19** is a cross-sectional view for describing a method of manufacturing an LED package **400**, according to exemplary embodiments of the inventive concept. The method of manufacturing the LED package **400** may basically include the method steps of manufacturing the LED package **100** as illustrated in FIGS. **7** through **17**. However, the method of manufacturing the LED package **400** may further include an operation of FIG. **19** between the operation of FIG. **16** and the operation of FIG. **17**.

Referring to FIG. **19**, the glass **90** formed in the operation of FIG. **16** may be etched along a sawing line along which the glass **90** is to be sawed in a chip size, in order to form a narrow groove **90**H on the glass **90**. The groove **90**H formed on the glass **91** may solve the problem that the glass **90** of FIG. **16** is not easily sawed due to its mechanical intensity when the LED package **400** at a wafer level is sawed in a chip size.

A sequential process as illustrated in FIG. **17** may be performed on an entire surface of the glass **91** to manufacture the LED package **400**. In this case, the glass **90** in the sequential process of FIG. **17** may be the glass **91** of FIG. **19**.

FIG. **20** is a cross-sectional view for describing a method of manufacturing an LED package **500**, according to exemplary embodiments of the inventive concept. The method of manufacturing the LED package **500** may include the method steps of manufacturing the LED package **100** as illustrated in FIGS. **7** through **17**. However, the method of manufacturing the LED package **500** includes an operation of FIG. **20** instead of the operation of FIG. **13**.

When the LED package **100** is manufactured in FIG. **13**, the fluorescent material layer **70** may be formed at a wafer level to cover the entire upper surface of the light-emitting structure **20***a*. However, referring to FIG. **20**, according to the operation of FIG. **20** instead of the operation of FIG. **13**, the fluorescent material layer **71** may be formed on the light-emitting structure **20***a* in a separated form in a chip size. In this case, the fluorescent material layer **71** may be formed to cover the upper surface of the light-emitting structure **20***a* including at least one pair of the first electrode pad **31** and the second electrode pad **33**. As a result, a plurality of the fluorescent material layers **71** may be formed on the light-emitting structure **20***a* with predetermined gaps from one another.

An adhesive material, a fluorescent material, or an adhesive fluorescent material may be spread on an upper surface of the above product, and a portion of a resulting product may be etched to form the support layer **84** filling the gaps between the plurality of fluorescent material layers **71** and being in contact with the upper surface of the light-emitting structure **20***a*.

Sequential processes of FIGS. **14** through **17** may be performed on an entire surface of the fluorescent material layer **71** and the support layer **84**, as illustrated in FIG. **20**, to manufacture the LED package **500**. In this case, the fluorescent material layer **70** in the sequential processes of FIGS. **14** through **17** may be the fluorescent material layer **71** and the support layer **84** of FIG. **20**.

A method of manufacturing an LED package **600** will be described, by referring again to FIGS. **18** and **20**. According to the operation of FIG. **18**, which may be performed after the operation of FIG. **12**, the second support layer **82** and the light-emitting structure **20***b* may be formed, and, the first support layer **84** and the fluorescent material layer **71** according to the operation of FIG. **20** instead of the operation of FIG. **13** may be formed on an entire surface of the second support layer **82** and the light-emitting structure **20***b*. Then, the sequential processes of FIGS. **14** through **17** may be performed to manufacture of the LED package **600**. In this case, the light-emitting structure **20***a* in the sequential processes of FIGS. **14** through **17** may be the light-emitting structure **20***b* and the support layer **82**, and the fluorescent material layer **70** may be the fluorescent material layer **71** and the first support layer **84**.

FIG. **21** is a view of a dimming system **1000** including a semiconductor light-emitting device, according to exemplary embodiments of the inventive concept.

Referring to FIG. **21**, the dimming system **1000** may include a light-emitting module **1200** and a power supply unit **1300** arranged on a structure **1100**.

The light-emitting module **1200** may include a plurality of LED packages **1220**. The LED package **1220** may include at least one selected from the LED packages **100**, **200**, **300**, **400**, **500**, and **600** described with reference to FIGS. **1** through **6**.

The power supply unit **1300** may include an interface **1310** for receiving a power and a power control unit **1320** for controlling a power supplied to the light-emitting module **1200**. The interface **1310** may include a fuse for blocking overcurrents and an electromagnetic waves shielding filter for shielding an electromagnetic waves trouble signal. The power control unit **1320** may include a rectifier for converting an alternating current into a direct current when the alternating current is inputted as a power, a smoothing unit, and a constant voltage control unit for converting voltage into a voltage suitable to the light-emitting module **1200**. The power supply unit **1300** may include a feedback circuit device for performing a comparison of an amount of light-emission and a predetermined amount of light-emission in each of the plurality of semiconductor light-emitting devices **1220**, and a memory device for storing information, such as a desired brightness and color rendition.

The dimming system **1000** may be used as an indoor illumination device, such as a backlight unit, a lamp, and a flat lighting used as a display device of a liquid-crystal display device including an image panel, or as an outdoor illumination device, such as a sign and a notice. Alternatively, the dimming system **1000** may be used as an illumination device of various means of transportation, such as vehicles, cargos, or airplanes, as an illumination device of home appliances, such as TVs and refrigerators, or an illumination device of medical equipment.

FIG. **22** is a block diagram of a light-processing system including an LED package according to exemplary embodiments of the inventive concept.

Referring to FIG. **22**, the light-processing system **2000** may include a camera system **2100**, a light-source system **2200**, and a data process and analysis system **2300**.

The camera system **2100** may be used by being arranged to directly contact a light-processing subject or by being spaced apart from and toward the light-processing subject by a predetermined distance. In some embodiments of the present inventive concept, the light-processing subject may be a biological tissue, such as skin or a treatment part. The camera system **2100** may be connected with the light-source system **2200** via a light guide **2150**. The light guide **2150** may include an optical fiber light guide that is capable of light transmission, or a liquid light guide.

The light-source system **2200** may provide a light that is irradiated onto the light-processing subject via the light guide **2150**. The light-source system **2200** may include at least one selected from the LED packages **100**, **200**, **300**, **400**, **500**, and **600**, described with reference to FIGS. **1** through **6**. In some embodiments of the present inventive concept, an ultraviolet ray may be generated in the light-source system **2200** and irradiated onto the biological tissue, such as the skin or the treatment part.

The camera system **2100** may be connected with the data process and analysis system **2300** via a cable **2160**. An image signal outputted from the camera system **2100** may be transmitted to the data process and analysis system **2300** via the cable **2160**. The data process and analysis system **2300** may include a control unit **2320** and a monitor **2340**. The data process and analysis system **2300** may process, analyze, and store the image signal transmitted from the camera system **2100**.

The light-processing system **2000** illustrated in FIG. **22** may be applied to various application fields, such as skin diagnosis, medical treatment, disinfection, sterilization, cleaning, surgery articles, beauty treatment, illumination, and information detection.

While the inventive concept has been particularly shown and described with reference to exemplary embodiments thereof, it will be understood that various changes in form and details may be made therein without departing from the spirit and scope of the following claims.

What is claimed is:

1. A light-emitting diode (LED) package, comprising:
- a light-emitting structure;
- a first electrode pad and a second electrode pad, connected with the light-emitting structure;
- an insulating pattern layer in contact with a bottom surface of the light-emitting structure and abutting the first electrode pad and the second electrode pad;
- a substrate including via-holes that are in contact with a bottom surface of the insulating pattern layer and expose a portion of the first electrode pad and a portion of the second electrode pad;
- a first penetrating electrode and a second penetrating electrode that are disposed in the via-holes and are respectively connected with the first electrode pad and the second electrode pad;
- a fluorescent material layer disposed on the light-emitting structure; and
- a glass disposed on and spaced apart from the light-emitting structure with the fluorescent material layer between the glass and the light-emitting structure.

2. The LED package of claim **1**, wherein the fluorescent material layer comprises an adhesive fluorescent material layer.

3. The LED package of claim **1**, further comprising an adhesive material layer disposed between the fluorescent material layer and the glass.

4. The LED package of claim **3**, further comprising a support layer disposed between the adhesive material layer and the insulating pattern layer to abut the light-emitting structure,
- wherein a first width of the substrate is greater than a second width of the bottom surface of the light-emitting structure.

5. The LED package of claim **4**, wherein the support layer comprises an adhesive material.

6. The LED package of claim **4**, wherein the second width is greater than a third width of an upper surface of the light-emitting structure.

7. The LED package of claim **1**, further comprising a growth substrate of the light-emitting structure, which is interposed between the light-emitting structure and the fluorescent material layer.

8. The LED package of claim **1**, wherein a fourth width of an upper surface of the glass is smaller than the first width of the substrate.

9. The LED package of claim **1**, wherein the glass is tapered from a bottom surface of the glass to an upper surface of the glass.

10. A dimming system, comprising:
- a light-emitting module including the LED package of claim **1**; and
- a power supply unit including an interface configured to receive power and including a power control unit configured to control power supplied to the light emitting module.

11. A light-processing system, comprising:
- a light-source system including the LED package of claim **1**;
- a light guide;
- a camera system connected with the light source system via the light guide and configured to output an image signal; and
- a data process and analysis system configured to process, analyse and store the image signal outputted from the camera system.

12. A light-emitting diode (LED) package, comprising:
- a light-emitting structure;
- a first electrode pad and a second electrode pad, connected with the light-emitting structure;
- an insulating pattern layer in contact with a bottom surface of the light-emitting structure and abutting the first electrode pad and the second electrode pad;
- a substrate including via-holes that are in contact with a bottom surface of the insulating pattern layer and expose a portion of the first electrode pad and a portion of the second electrode pad;
- a first penetrating electrode and a second penetrating electrode that are disposed in the via-holes and are respectively connected with the first electrode pad and the second electrode pad;
- a fluorescent material layer disposed on the light-emitting structure and having a second width smaller than a first width of the substrate;
- a first support layer abutting the fluorescent material layer disposed on the light-emitting structure; and
- a glass disposed on and spaced apart from the light-emitting structure with the fluorescent material layer between the glass and the light-emitting structure.

13. The LED package of claim **12**, wherein the first support layer comprises an adhesive material.

14. The LED package of claim **12**, wherein the first support layer comprises a fluorescent material.

15. The LED package of claim **12**, wherein the first support layer comprises an adhesive fluorescent material.

16. The LED package of claim **12**, further comprising a second support layer abutting the light-emitting structure between an upper layer including the first support layer and the fluorescent material layer and a lower layer including the insulating pattern layer,
- wherein a third width of the bottom surface of the light-emitting structure is smaller than the first width of the substrate.

17. The LED package of claim **16**, wherein the first support layer and the second support layer include an identical material.

18. A dimming system, comprising:
- a light-emitting module including the LED package of claim **12**; and

a power supply unit including an interface configured to receive power and including a power control unit configured to control power supplied to the light emitting module.

19. A light-processing system, comprising:

a light-source system including the LED package of claim **12**;

a light guide;

a camera system connected with the light source system via the light guide and configured to output an image signal; and

a data process and analysis system configured to process, analyse and store the image signal outputted from the camera system.

20. A light-emitting diode (LED) package, comprising:

a light-emitting structure including a first semiconductor layer, an active layer and a second semiconductor layer;

a first electrode pad and a second electrode pad, respectively connected with the first semiconductor layer and the second semiconductor layer of the light-emitting structure;

an insulating pattern layer in contact with a bottom surface of the light-emitting structure and disposed between the first electrode pad and the second electrode pad;

a substrate including via-holes that penetrate the substrate and expose a portion of the first electrode pad and a portion of the second electrode pad;

a first penetrating electrode and a second penetrating electrode that are disposed in the via-holes and are respectively connected with the first electrode pad and the second electrode pad,

wherein a first width of the bottom surface of the light-emitting structure is greater than a second width of an upper surface of the light-emitting surface and smaller than a third width of the substrate.

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